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Observations and Conjectures on the Formation and Nature of the Soil of Kentucky. By J. Correa de Serra.—Read, April 21, 1815.

THE surprising fertility of that part of the state of Kentucky commonly called the *Elkhorn Tract*, and of many of the adjoining tracts in several directions, particularly to the south west, is so generally known in America, that I may, without inconvenience, forego the details of the extraordinary luxuriance of vegetation, and richness of crops that take place in it. The following observations and conjectures are only directed to attempt an explanation of the causes of the wonderful fertility of that soil, and I leave to books of travels and to statistical writers the care of mentioning the instances or appreciating the amount of its uncommon productiveness.

It is well known that the country to the west of the Alleghanies, is of a different and more recent formation than that of the countries situated to the east of this long ridge of mountains. Granitic or amphibolic rocks, primitive limestone, disposed in broken strata with an obliquity from 40 to 50 degrees from the horizon, are the chief components of the country on the east of the Alleghanies. Their disposition and combinations abundantly show that this part of the world, is among those which have claims to a formation of very ancient date, and that they have been worked and shaped by one or more posterior revolutions, into their present appearance.

The country to the west of the Alleghanies, is, on the contrary, all formed of horizontal strata ; whether the stones that form its several parts be siliceous, argillaceous or calcareous. Certainly the formation of that country, is posterior to the revolutions that have overturned every where the strata of the materials which form the country to the east of the Alleghanies. If this western country had been coeval, nothing could have saved its strata from partaking of the same catastrophes, and being dislocated in the same manner. These western strata contain imbedded in them an immense quantity of marine shells, and other organised bodies belonging both to the animal and vegetable kingdom. The vegetable remains in particular, are in such astonishing abundance, that they form thick strata of coals extending in some parts to hundreds of miles, keeping always nearly the same level, as it is particularly ascertained of that stratum of excellent coals which is now worked at *Coal Hill*, opposite to Pittsburgh, on the other side of the Monongahela.

It is clear from these phenomena, that the soil of all this basin contained between the foot of the Andes, the highlands to the north of the lakes, and the Alleghanies, has not only been formed after these last mountains, but also at an epoch when the organised bodies were already in existence ; and moreover, that the precipitation and deposition of the materials which have filled this space, have been calmly and quietly worked by nature as in a sheltered harbour, where the turmoils of the primitive ocean had little effect.

But though all this region is in the same predicament as to its original formation, still there are strong appearances of a part of it having been left by the ocean after the other, and of its being comparatively of a more recent epoch. The materials that form it, are very probably the last, and, in some respects, incomplete operation of the sea before its total retreat, as the following considerations seem to indicate.

Almost every part of the country to the north of the Ohio, the western parts of Pennsylvania and Virginia, the eastern part of Kentucky, and as far as my information goes, all the

East Tennessee, are formed, it is true, of horizontal strata, but compact enough, mixed in many parts with argillaceous slate, and the strata of limestone are sometimes interrupted with other strata of siliceous stones. The calcareous themselves are almost always but sparingly provided with fossil remains of shells. These stony strata are generally covered by many others of argillas, sand, and of gravel and rolled pebbles. Above these, is the vegetable soil commonly of a good quality, but in the same proportions as it is found in other fertile countries, and nearly of the same nature as in the good parts of Pennsylvania.

All this region is high, composed of hills commonly steep, with narrow tops, intermixed with valleys of different breadth, but generally flat, wide, and filled with alluvial soil, which the currents of water have taken from higher grounds and deposited there ; consequently of a superior fertility to the upland. The horizontal position of the strata, has in some places undergone a partial and slight alteration, and over all the surface of this region, particularly in the state of Ohio, are not unfrequently found considerable insulated fragments of stones, of more primitive formations, such as siliceous, puddingstones, &c. and if I am not mistaken, granitellos, and porphyritic stones, carried from their original distant situations by the currents of the ocean, when covering these spaces.

Far different from this is the nature and aspect of the country, the extraordinary fertility of which is the subject of this paper. The whole of this tract is of a lower level than the preceding, a great presumption this, of its more modern formation, because the lowest parts of the terrestrial surface have naturally been the latest relinquished by the sea. No diversity of stones is found here, but every where a pure, soft, carbonate of lime, which is generally about the surface of a tender texture, disposed in very thin horizontal strata, not commonly thicker than the sheets of argillaceous schists. It does not acquire compactness but at a certain depth, and even then it appears of the most fine homogeneous texture, as may be observed in all the blocks of Kentucky marble. In all its

states this calcareous stone is filled with marine shells, amongst which the genus *terebratula* seems the more predominant. The horizontality of the strata is most striking. Above this carbonate of lime, scarce any earth, sand or gravel appears; but a thick bed of soft black saponaceous, but not adherent, loam, from three to sixteen feet in depth, which is the seat of the most amazing vegetation.

The aspect of the country, is very different from that of the preceding region. It is not a flat plain, but one strongly undulated, the tops of the high lands are wide extended, the furrows of the water courses very narrow, nowhere accompanied by any thing like flat vallies or bottoms. Contrary to what happens almost any where else, the wide extended tops of the hills are endowed with an unbounded fertility, and this diminishes on their sides in proportion as you descend to the water courses. This simplicity of structure, this homogeneity of composition, together with the lower level of this region, afford strong presumption that all this tract has undergone still less revolutions than the rest of the western lands, and that the deposition of the materials that form it, was one of the last operations of the power of the ocean before it left this western continent wholly uncovered.

The almost immediate superposition of this very thick body of fine vegetable soil on the tender layers of carbonate of lime, is a phenomenon not easily explained in the ordinary ways. We must remember that the productive soil of every country is composed of the friable detritus of the stony materials of which the country is formed; almost always covered by a light stratum of mould, proceeding from the rotten remains of vegetables, which, in the process of ages had covered its surface. This detritus of the stony materials of each country, partakes of the nature of the rocks from which it is taken, and contains the chemical principles of the earths which entered into the composition of these stones. Hence the different nature and fertility of soils. A constant observation has shewn that argillaceous and calcareous earths, but chiefly the last, were the most propitious to vegetable production, and mixed with the decom-

posed materials of organised bodies, constituted by their several proportions the basis of strong vegetation.

The superior stratum of vegetable mould, is in all countries generally thin, and if we reflect on the nature of vegetables, and of their nutrition and decomposition; it is easily perceived that it cannot be otherwise. Gases and water constitute by far the greatest part of the aliments of plants, and into the same principles they are easily dissolved. If we find this vegetable mould apparently plentiful in a decayed or rotting tree, successive evaporation of moisture and developement of gases daily reduce its bulk, and the remains of a gigantic tree left to the decomposing process, must in a series of years be reduced to a few ounces of perceptible matter, still liable to further gaseous decomposition. The quantity of organic decomposed matters remaining in the soil is small indeed, and on examination almost every where this superior layer of mould is not simply vegetable matter, but the result of the decomposition of vegetables incorporated and combined with the earth of the stratum immediately under it.

One exception only exists to this universal rule. The bottom of rivers where the annual inundations quietly deposit a sediment of the more soluble parts of earth, which, in their course they have detached from their original stations, in the long lapse of ages treasure a thick mass of fat loam, washed from a wide extended surface of soil. But the country, of which we speak, has nothing common with these river bottoms, the highest parts of it are the most fertile, and thickness of loam and fertility both diminish in proportion as the surface is lower.

Let us now remember the unbounded deposits of fossil vegetables which are found in this western region, the coal stratum of Pittsburgh for instance, extending for hundreds of miles. Let us also reflect on the difference of the alterations which vegetable bodies undergo when decomposing, if imbedded between stony strata of a ponderous solid nature, or only covered by light permeable strata of earth, or under a column of water. How

different are these operations from their decomposition in the atmosphere ! In the first case the pressure of a solid stratum, the heat of a fermentation which cannot work but on itself, where no principle is lost, but all of them form new combinations, reduce the decomposed vegetables to the state of coals. In the second case, when decomposed under water, or under light materials, strata are formed of fossil half rotten wood, imbedded in rotten leaves, and when this mass is exposed to the action of the atmosphere, it is soon converted into a black, soft, saponaceous matter, not unlike the loam of Kentucky. Such subterraneous and submarine forests of vast extension are more common than is generally supposed. The Atlantic states of America, in their alluvial parts, offer in the digging of wells abundant reasons to believe that like deposits are contained under their soil. In Europe they have been observed in several parts. I have had the pleasure myself of making known, in the Philosophical Transactions, that the eastern part of England contained, at the depth of sixteen feet, a subterraneous and submarine forest, the remains of which could be traced from near the mouth of the Humber to Peterborough, a distance of about an hundred miles.

If such a deposit is not covered by any other substance, it is clear that if left dry by the retreat of the water, it must become such another soil as that of the *Elkhorn Tract*, to a depth proportionate to the quantity of rotten vegetables.

In resuming these facts, great reasons I believe exist, for more than suspecting that the soil of this part of Kentucky is but a bed of vegetables, the deposit of which has been the last operation of the waters before their final recess, and which not being covered by any other heavy material, have been left to rot and dissolve themselves into mould of a depth proportionate to their vast quantity. Only thus can we explain the depth of the Kentucky mould, because no forests growing on the spot could ever have produced it, as they do not produce it in other countries where they have vegetated from the creation. The soft fossil shells, and tender carbonate of lime, on which this mould lies, and with which, no doubt, it is mixed

in some proportion, afford the happiest combination that nature presents to improve fertility. The calcareous earth is the only one that water can nearly perfectly dissolve, and with it the animal principles which the fossil shells contain. The theory and practice of manures offers nothing superior to such combination.

From all the preceding considerations, I am disposed to conclude that the soil of the millions of acres which constitute the Elkhorn Tract, and its ramifications, is the produce of the decomposition of an immense *deposit* of vegetables, which the ocean had left uncovered by any other deposition. Such naturally, would have been the soil of all that large portion of country, where the coals are found at a constant depth in West Pennsylvania, West Virginia, and Ohio, if the vegetable *depot* had not been covered by the heavy materials which form the few superincumbent strata.